NEW ENGLAND

PCB WASTE

MANAGEMENT STUDY

SOLID WASTE PROGRAM

AIR AND HAZARDOUS MATERIALS DIVISION

REGION I

U.S. ENVIRONMENTAL PROTECTION AGENCY

NOVEMBER 1976

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CHAPTER I

INTRODUCTION

A. History of PCB Use

The term polychlorinated biphenyl (PCB) refers to a family of stable organic chemicals which have been produced and marketed in this country since 1929. These chemicals are extremely advantageous for use as dielectric and heat transfer fluids because of certain properties they exhibit including: low solubility in water, low vapor pressure, low flammability, high heat capacity, low electrical conductivity, favorable dielectric constant, and suitable viscosity-temperature relationships. Because of these properties, and also because PCBs exhibit little acute toxicity (toxic effects from high level, short term exposure), this family of materials has been extensively used in many industrial applications, primarily in "closed" or "semi-closed" systems such as electrical transformers and capacitors, heat transfer systems, and hydraulic systems. Most of the PCBs marketed to U.S. industry are still in service, primarily in electrical equipment. The remainder have entered the general environment; a significant fraction of this amount is present in air, water, soil, and sediment, but most of the PCBs in the environment are believed to be in landfills and dumps across the country.

In the late 1960's it became apparent that, although PCBs exhibit little acute toxicity, they are accumulated in the tissues of many biological species and do exhibit chronic (long-term) toxicity to many species even when the exposure is to very low concentrations. The effects of chronic PCB exposure vary in different animal species; they include skin, liver and kidney lesions in rabbits as well as chloracne and hepatotoxic effects in man.

The recognition of this problem resulted in a major program designed to lessen the environmental stress arising from widespread use and dissemination of PCBs; by mid-1971, the Monsanto Industrial Chemicals Company, the sole U.S. producer, had voluntarily terminated sales of PCBs (PCBs and polychlorinated triphenyls, or PCTs) for all but closed electrical systems uses. Monsanto also, in the same time frame, offered incineration services for waste liquid PCBs and terminated production of the most highly chlorinated PCBs.

After approximately five years of the voluntary industrial restrictions, a National Conference on PCBs was held in Chicago during November 1975, under the joint sponsorship of EPA and other Government Agencies. By that time it had become apparent that improved analytical techniques plus more extensive monitoring efforts had revealed that PCB contamination at environmentally significant levels was more widespread than originally thought.

Results presented at the Chicago meeting indicated PCB levels in the environment, on an overall basis, have been more or less constant since 1971, although there were local instances of both increases and decreases in PCB levels. It thus appears that, unlike DDT, elimination of PCBs from dissipative uses has not resulted in a significant reduction in environmental load.

Consequently, in December 1975, a comprehensive plan was initiated within EPA to reduce as rapidly and effectively as possible the serious threat of PCBs to human health and the environment.

As part of this plan, the Regional Offices of the EPA were directed by the Administrator to undertake surveys of the major PCB users in the United States. The primary purpose of these surveys was to determine the precise manner in which PCBs enter the land, air and water from each facility and also to determine what measures could be taken to eliminate or minimize such PCB contamination.

B. Objective of the Study

The objective of this study is to evaluate PCB waste management practices utilized in New England. As part of this evaluation an attempt has been made to quantify and qualify losses of PCBs to the environment resulting from the processing and disposal of PCB contaminated solid and liquid wastes.

C. Scope of the Study

The primary emphasis of this study focuses on the past and present PCB waste streams generated directly or indirectly by the transformer and capacitor manufacturing plants located in New England. While other minor PCB users in New England were identified, resource limitations necessitated that investigations of the facilities not be included in this report.

Prior to 1970 PCBs were used in various consumer products (paints, plastics, sealants, lubricant additives) and in various industrial applications (hydraulic fluids, heat transfer fluids) in addition to electrical equipment. When discontinued or discarded, these PCB uses have been and continue to be a source of PCBs entering the environment. Consequently, the study was expanded to include a limited investigation of those disposal methods (municipal incinerators, and municipal and private disposal sites) utilized to handle commercial and domestic wastes.

The Solid Waste Program directed its efforts to the following specific activities:

1. As part of a work team made up of various EPA program personnel, an investigation was made of the following capacitor and transformer manufacturing plants located in New England.

Company	Location	PCB Product
Aerovox Industries, Inc.	New Bedford, MA	Capacitors
Cornell-Dubilier Electronic Corporation	New Bedford, MA	Capacitors
General Electric Company	Pittsfield, MA	Transformers
Jard Company, Inc.	Bennington, VT	Capacitors
Sprague Electric Company	North Adams, MA	Capacitors
Universal Manufacturing Corporation	Bridgeport, CT	Capacitors

For this report the primary purpose of these plant investigations was to determine the quantities and characteristics of the solid and liquid wastes generated and the waste processing and disposal methods utilized.

A limited investigation was also undertaken of sludge disposal practices at those sewage treatment plants known to be treating PCB contaminated effluents from the identified capacitor and transformer manufacturing plants in New England. Sludge samples were collected and analyzed for PCB concentrations.

2. A field investigation and sampling effort was undertaken in the following three areas:

A. An investigation was made of the potential for PCB contamination of surface and subsurface water caused by drainage from land disposal sites. The types of sites studied were divided into three categories:

i. Those disposal sites identified as having received substantial quantities of PCB liquid and/or solid wastes from the capacitor and transformer manufacturing plants.

ii. Those sites receiving substantial volumes of industrial wastes but not specifically PCB wastes from the capacitor and transformer manufacturing plants.

iii. Disposal sites receiving primarily residential and commercial wastes.

B. The concern over the potential environmental contamination from PCBs contained in discarded consumer products also initiated an investigation of air emissions from a municipal refuse incinerator. The Stamford, Connecticut municipal incinerator was selected for this emissions study.

C. Because of the current problems involved with disposal of reject capacitors, Aerovox, Inc., of New Bedford, Massachusetts experimented with a procedure to evacuate the PCBs from their reject capacitors. Working with Aerovox, an attempt was made to evaluate the effectiveness of this evacuation procedure.

CHAPTER II

BACKGROUND

A. Problem Definition

PCBs are a class of organic compounds manufactured by the chlorination of biphenyl with anhydrous chlorine using iron filings or ferric chloride as a catalyst. The biphenyl molecule has a total of ten carbon-hydrogen bonds at which chlorine substitution can be accommodated. In the manufacture of PCBs, anywhere from one to ten chlorine atoms may be located on the biphenyl molecule.

The PCBs manufactured by Monsanto are marketed under the trade name Aroclor followed by a four digit number, with "biphenyl" represented by the first two digits "12", and the approximate chlorine percentage represented by the second two. Thus, Aroclor 1242 is a mixture containing approximately 42 percent chlorine. The principal Aroclors which have been marketed over the past decade by Monsanto are 1221, 1232, 1242, 1248, 1254 and 1260, although at this time there is no active marketing of 1232, 1248 or 1260. In addition, Aroclor 1016 (an exception to the previously identified nomenclature system) is being marketed, and bears approximately 41.3 percent chlorine.

The unique physical and chemical properties of PCBs include low vapor pressure at ambient temperatures, resistance to combustion, remarkable chemical stability, high dielectric constant and high specific electrical resistivity and low water solubility.*

* For an extensive discussion of the chemical and physical properties of PCBs, see O. Hutzinger, S. Safe, and V. Zitho. "The Chemistry of PCBs." CRC Press 1974.

At the same time, PCBs are lipid soluble and hence the potential for absorption into fatty tissue and into the liver is high. Thus once ingested PCBs are retained by most organisms rather than excreted. The qualities of persistence which make PCBs useful for many industrial purposes greatly aggravate their potential for harm in the ecosystem. Although the principal uses of PCBs today are in "closed" electrical systems (transformers and capacitors), PCBs have been used over the years for a variety of more "open" uses resulting in greater direct contamination of the environment.

These other uses include an additive in investment casting waxes, lubricant additive, hydraulic and compressor fluid, carbonless copy paper, plasticizers, paints, heat exchange fluids, certain types of paper and sealants. Most of these uses have been substantially curtailed but the PCBs which have entered the environment as a result of these uses, and which continue to be placed in the environment, will be there for many years.

It is estimated that over the past 45 years approximately 1.4 billion pounds of PCBs have been produced in the United States, of which 1.25 billion have been used in this country and the balance exported. Of this 1.25 billion pounds, approximately 960 million pounds have been used in electrical equipment. In addition, it is estimated that only approximately 50 million pounds have degraded, that 750 million pounds are presently in service, and that 290 million pounds are in land disposal sites and 150 million pounds are believed to be "free" in the environment(in air, water, soil and sediment). The magnitude of these values indicates that there is a strong future threat from PCBs in land disposal sites.

B. Transformer Manufacturing

There are thirteen companies in the US which manufacture PCB transformers at eighteen plants. One of these plants, a General Electric Plant, is located in New England in Pittsfield, Massachusetts.

There are two broad classifications of transformers: distribution transformers, which are used to step down voltages, and power transformers, which are used primarily to step up voltages. In general a transformer consists of a core and coil immersed in a dielectric fluid (a nonconducting fluid). The primary dielectric fluid used in transformers is mineral oil with only 5 to 10 percent of the transformers produced containing PCB transformer oil (blends of 60 to 70 percent Aroclor 1254 or 1242 and 40 to 30 percent trichlorobenzene).

The amount of PCB oil used in individual transformers ranges from 30 to 1,500 gallons (516 to 19,350 pounds) with an average of about 232 gallons (3,000 pounds). General Electric estimates that the total PCB-insulated units that have been put into service in the United States since 1932 is 135,000, and virtually all of these units are still in service. The lifetime-before-failure is often longer than 30 years, and almost all units that do fail are rebuilt and returned to service. The current production rate of PCB transformers is about 5,000 units per year.

Most plants manufacture all the hardware and components necessary for the transformer assembly. The transformer interiors and the containers are brought to the PCB filling stations where transformers are assembled, filled and sealed.

The filling operation is done in a designated station. At plants where large quantities of P C B are handled, the filling operation is conducted on gratings located on sumps. The sumps are inspected and cleaned periodically. All scrap PCB from the sumps is pumped into drums and sent to incineration facilities.

Various transformer assembling and filling procedures are being practiced throughout this industry. In general, all transformer assembling and filling operations consist of a predrying step for removing moisture from the transformer interiors, several stages of PCB filling, PCB topping, addition of electrical connections and bushings, electrical testing and sealing.

Liquid PCB Handling - The General Electric Plant in Pittsfield, Massachusetts purchases PCBs and trichlorobenzene and does their own compounding. The PCBs, which are shipped via rail car, are pumped into a storage tank and mixed with the trichlorobenzene. This mixture is next filtered through diatomacious earth and a plate and frame type filter for final cleaning and is then stored in finished product tanks.

The mixed PCB fluid is next trucked to an uncovered/bermed tank farm area. Here the truck enters a sheltered area, and the PCB liquid is pumped from the truck into a distribution storage tank. From this tank the PCB liquid is pumped to eight handling stations located throughout the production area.

Recycled PCB from the manufacturing operations is generally returned through pumps into a storage tank or into 55 gallon drums and from there it is either filtered for reuse or sent to incineration if defective.

C. Capacitor Manufacturing

There are seventeen companies in the U.S. which manufacture PCB capacitors at nineteen plants. Five of these plants are located in New England.

A capacitor consists of an aluminum or steel can into which is placed a roll winding of kraft paper and/or polypropylene film with aluminum foil impregnated with PCBs. Figure 1 is a photograph of several smaller capacitors and their contents.

Presently 90-95 percent of all impregnated capacitors manufactured in the U.S. are of the PCB type. Two important types of capacitors are phase correctors on power lines and ballast capacitors for fluorescent lighting. Aroclor 1016 is the prinicipal PCB used in this application.

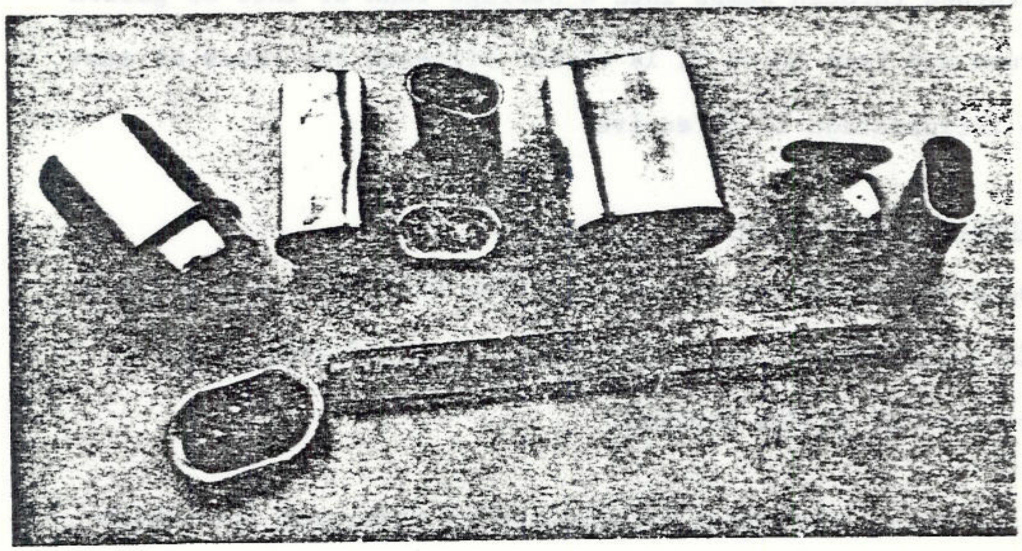

FIGURE 1. TYPICAL PCB CAPACITORS

Capacitors used in lighting and air conditioning applications contain 0.05 to 1.0 pounds of Aroclor. The largest power capacitors contain about 77 pounds of Aroclor, with the most popular size containing 36 pounds. Capacitors are not rebuilt and returned to service after failure. They are disposed of and replaced by new units.

The current market for capacitors used in lighting applications is about 44,000,000 units annually of which 10% are estimated to be replacement ballasts. The current market for capacitors in air conditioning application is above 12,000,000 units annually, with 5% of these estimated to be for replacement usage. The market for capacitors in industrial electronics applications is estimated at 28,000,000 units per year with no estimate as to the relative size of the replacement market.

Liquid PCB Handling - In most capacitor manufacturing plants PCBs are shipped via tank car to a rail siding several miles from the plant. A specially designated tank truck is then utilized to transfer the PCBs from the rail yard to the manufacturing plant. PCBs are then unloaded from the tank trucks and transferred to storage tanks, usually without the benefits of any curbs or dikes.

From the raw storage tanks, the PCBs are filtered through Fuller's earth and stored in finished product storage tanks. The PCBs are then pumped to the impregnation area where small capacitors are flood filled in a vacuum tank and large capacitors are either flood filled in a vacuum tank or filled directly through a hose connected to the capacitor.

Liquid PCB contaminated during the impregnation process is pumped into a designeated tank and from there either filtered and reused, or if defective, pumpted to a scrap storage tank.

CHAPTER III

STUDY RESULTS

A. Results of Capacitor and Transformer Manufacturing Plant Surveys

The following information on the five capacitor and one transformer manufacturing plants located in New England was acquired during plant visits by EPA personnel and by official EPA enquiries sent out under Section 308 of the Federal Water Pollution Control Act.

1. Quantities and Characteristics of PCB Waste Generated

The types of PCB wastes generated as a result of the manufacturing of capacitors and transformers can be divided into liquid wastes (excluding wastewater effluent) and solid wastes:

Liquid wastes consists primarily of PCB so contaminated during the manufacturing process that it cannot be upgraded by filtration for reuse. Other sources of liquid wastes include sumps, drums and drip pans, contaminated vacuum pump oils, fractionator bottoms from the trichloroethylene recovery, spent detergent washwater from the capacitor cleaning operation (from the Jard Plant in Vermont), and spent PCB vacuum pump heat transfer fluid (from Universal Manufacturing Corporation in Connecticut).

Solids generated consist primarily of reject capacitors and miscellaneous contaminated wastes. Reject capacitors (3 to 5% of the capacitors producted are rejected for mechanical or electrical reasons) represent the bulk of the solid waste generated at the capacitor manufacturing plants. Miscellaneous wastes include absorbent material used to clean small spills and drippings, cotton and rubber gloves, spent filter media used to upgrade contaminated PCBs, wiping rags and newspapers.

Table 1 presents a summary of the quantities of PCB liquid and solid wastes generated by each of the six major PCB users in New England for the years 1971 thru 1974. Adequate data to quantify each of the wastes generated at these capacitor and manufacturing plants is not available.

TABLE 1

PCB INDUSTRIAL WASTE

GENERATION IN NEW ENGLAND

(1971 thru 1974)

Year	Liquids (lbs.)	Solids (lbs.)*
1971	362,000	157,090
1972	296,040	228,130
1973	601,910	280,430
1974	440,550	276,680
Total	1,700,000	942,330

Total liquids and solids 2,642,830 lbs.

* Solid waste quantities primarily represent reject capacitors. Data on solid PCB waste generated by G.E. Pittsfield not available

2. PCB Waste Processing and Disposal

This second section on the results of the plant surveys has been broken down into the following three categories: liquid PCB wastes, solid PCB wastes, and PCB contaminated sludges.

Liquid PCB Wastes - Prior to 1970 liquid PCB wastes were disposed of primarily in municipal and private land disposal sites, with some quantities being used as dust suppressant on dirt roads. Table 2 contains a summary of the historical PCB wastes processing and disposal practices utilized by the major PCB users in New England.

With the growing concern over PCB in the environment and the availability of Monsanto's liquid incinerator, most of the liquid PCB wastes generated in New England since 1970 have been processed in liquid incinerators.

There are currently several commercial incinerators available for disposal of liquid PCB wastes (See Appendix A). One of these incinerators has been developed by the General Electric Company

PCB INDUSTRIAL WASTE DISPOSAL PRACTICES

IN NEW ENGLAND

Company	PCB Solids Disposal	PCB Liquids Waste Disposal
1. Aerovox Industries, Inc.	Prior to 1971 - New Bedford Municipal Incinerator Shawmut Avenue (Ash disposed of on site). 1971 thru 1975 - New Bedford Municipal Disposal Site Shawmut Avenue. 1976 to date - Storage on site. Awaiting development of State policy. Quantities generated: 218,000 lbs. from 1971 thru 1974.	Prior to 1971 - Exact disposal methods unknown. Is suspected large quantities went to New Bedford Municipal Disposal Site. 1971 to date-commercial liquid incineration. Quantities generated: 320,000 lbs. from 1971 thru 1974.
2. Cornell-Dubilier Electronic Corporation	Disposal Methods same as for Aerovox Industries (See Above) Quantities generated: 244,300 lbs. from 1971 thru 1974.	Quantities generated: 669,000 lbs. from 1971 thru 1974.
3. General Electric	1932 thru 1948 - No records available G.E. serviced by various private disposal sites. 1948 thru 1970 - Wastes processed by Pittsfield municipal incinerator (closed 1953). After closure of incinerator wastes were hauled to municipal disposal site. 1971 to date - Storing PCB contaminated wasted in 55 gallon drums in G.E. scrap yard in Pittsfield. Quantiites Generated: No data available	1932 thru 1970 - No records available. Suspect liquid used as dust suppressant and disposed of in various private disposal sites. 1971 to date - stored on site 1973 on-site liquid incinerator became operational Quantities Incinerated: 269,775 lbs. from 1973 thru 1st 6 months 1975

	Company	PCB Solids Disposal	PCB Liquids Waste Disposal
4.	Jard Company, Inc.	1970 thru 1975-Bennington, Vermont Municipal Disposal Site. 1976 to date-storage awaiting shipment to out of State disposal site. Quantities generated: 153,700 lbs. from 1971 thru 1974	1970 thru 1971 - Bennington, Vermont Municipal Disposal Site. 1972 to date - commercial liquid incineration. Quantities: 49,500 lbs. From 1972 thru 1974
5.	Sprague Electric Company	1950's thru 1975 - North Adams Municipal Disposal Site. 1975 to date - storage on site, awaiting development of State policy. Quantities generated: 178,000 lbs. From 1971 thru 1974.	1950's to 1971 - No records available. 1971 to date - commercial liquid incineration Quantities generated: 507,000 lbs. From 1971 thru 1974.
6.	Universal Manufacturing Corporation	1959 thru 1975 - Bridgeport Municipal Incinerator. 1976 to date - storage on site, awaiting development of State policy. Quantities generated: 144,200 lbs. from 1971 thru 1974.	1959 thru 1969 - Bridgeport Municipal Sea Side Park Disposal Site. 1970 thru 1975 - Private landfill in Cranston, Rhode Island. 1976 to date - Storage awaiting commercial incineration. Quantities generated: 137,000 lbs. from 1971 thru 1974.

in Pittsfield, Massachusetts in order to adequately destroy the liquid PCB wastes generated by their Pittsfield transformer manufacturing operation.

In September of 1974, EPA, Region I conducted a stack test on this liquid injection incinerator to demonstrate the ability of this unit to destroy liquid DDT. During the course of this test, PCB waste oil was utilized as a supplemental fuel. The results of the test burn indicated that the G.E. facility had a very high destruction efficiency with both DDT and PCB (99.99%).* Table 6 provides background information on the operating characteristics of this facility and the PCB test data.

Solid PCB Wastes - Historically, the primary method of disposal in New England of PCB solid wastes has been via the municipal disposal operation (i.e. municipal incineration or land disposal) with some quantities going to private disposal sites. See Table 2 for a summary of the historical disposal methods and disposal sites utilized by the six major PCB users in New England.

*For a detailed discussion of this test burn see: EPA Region I Report: "Demonstration Test Burn of DDT in General Electric's Liquid Injection Incinerator", by I. Leighton and J. Feldman.

As a result of discussions with federal and state officials, the PCB capacitor and transformer manufacturers in New England have discontinued the practice of disposing of their PCB wastes in conventional landfills and municipal incinerators.

Currently, the major PCB users in New England are reportedly either storing their PCB solid waste (primarily reject capacitors) awaiting development of local secure disposal facilities or sending their wastes to out-of-state hazardous waste management facilities for proper disposal. (See Appendix A for list of available facilities).

Table 3 contains a summary of background information on those disposal sites known to have received industrial solid and liquid PCB wastes.

<u>PCB Sludge Disposal</u> - The manufacturing plants of the six major users of PCB in New England have wastewater discharges that are treated by a total of five municipal sewage treatment plants. (See Table 4) These plant discharges contain measurable quantities of PCBs. Previous studies have indicated that PCBs in the influent to sewage treatment plants tend to concentrate in the sewage sludge. Because of the concentration affect, PCB analysis was performed on sludge samples taken from each of the five sewage treatment plants. Sludge generation rates were estimated and current processing

TABLE 3

SUMMARY OF BACKGROUND INFORMATION ON LAND DISPOSAL SITES

Location of Site	Owned/ Operated by	Approx. Age of Site	Approx. Total Area	Approx. Total Area Filled	Geology Soils	Depth to Ground Water	Proximity to Surface Water
New Bedford, MA	City of New Bedford	56 Years	40 Acres	24 Acres	Wetland Peat underlain by sand and silt	Water at Surface	1/2 Mile to Piskamanset River
Bennington, VT	Town of Bennington	8 Years	28 Acres	8 Acres	Abandoned Gravel Pit	0 to 8'	700' to intermittent stream
Pittsfield, MA	City of Pittsfield	24 Years	42 Acres	36 Acres	Sand and Gravel	15'	50' to Housatoric River
North Adams, MA	Town of North Adams	41 Years	72 Acres	36 Acres	Sand and Gravel	35'	50' small Spring Fed Stream
Bridgeport, CT	City of Bridgeport	20 Years	125 Acres	125 Acres	Sand	0	200' to Long Island Sound
Cranston, RI	Sanitary Landfill Inc. (Private)	28 Years	40 Acres	40 Acres	-	-	450' to Pawtucksett River

Source: State Solid Waste Officials

and disposal methods were examined. Results from this effort are presented in Table 4. As Table 4 indicates the two primary disposal methods utilized are land disposal/application and incineration.

Historically the sludge from the Bennington wastewater treatment plant went to the Bennington municipal disposal site which has also received large quantities of PCB wastes from Jard Manufacturing Company (See Table 2).

Sludge from the Pittsfield Sewage Treatment has always been disposed of on the 125 acre site where the sewage plant is located. An investigation has not been undertaken of this site which is located next to the Housatonic River.

Both of these plants reported that limited quantities of their sludge were taken by home owners for use on home gardens. (Both flower and vegetable.) It was recommended by EPA to the plant operator that this practice be discontinued.

The small quantities of sludge generated by the North Adams Sewage Treatment Plant is used as a soil conditioner at various municipal facilities (golf course, cemetery, little league field). Starting in December 1976, the wastewater treated by the plant will be treated by a new regional plant in Williamstown, Massachusetts.

TABLE 4

SEWAGE SLUDGE QUANTITIES AND COMPOSITION

Wastewater Treatment Plant Location	Major PCB Source	Estimated Quantities Of Sludge Generated (tons/wk)	Sludge Disposal Method	Aroclor Detected	PCB Concentrations (ppb)	Date Of Sample Collection
1. Bennington, VT	Jard Manufacturing Company	5 (40% solids)	municipal land disposal site	1016	sediment-2800	3/76
				1254	sediment-2000	
2. Bridgeport, CT	Universal Manufacturing Company	35 (20% solids)	sludge multiple hearth incineration	1016	sediment-46000	5/76
				1254	sediment-5200	
3. New Bedford, MA	Aerovox Industries Inc.	42 (22% solids)	sludge multiple hearth incineration	1016	sediment-64000	3/76
				1254	sediment-9600	
	Cornell-Dubilier Electronic Company			1016	sediment-28000	4/76
				1254	sediment-2800	
				1016	sediment-39000	4/76
4. North Adams, MA	Sprague Electirc Co.	1 (6% solids)	used as soil conditioner at municipal facilities	1016	sediment-28000	5/76
				1254	sediment-6400	
5. Pittsfield, MA	General Electric Corp.	31 (40% solids)	land disposal on site	1016	sediment-1400	2/76
				1254	sediment-8000	
				1260	sediment-8000	

Both the New Bedford and Bridgeport Municipal Sewage Treatment Plants utilize multiple hearth sludge incinerators as a means of processing their sludge. Tests have shown that sludge incinerator emissions can contain persistent organic compounds, such as PCBs. The results of the emissions tests performed on the Palo Alto, California Municipal Sludge incinerator are contained in Table 6.

The "Proposed Technical Bulletin on Municipal Sludge Management: Environmental Factors"[3] recommends that if the PCBs exceed 25 mg/kg (ppm) dry sludge, then special measures should be taken to ensure at least 95 percent destruction of the PCBs in incineration. The concentrations of PCBs in the sludge at both the New Bedford and Bridgeport Sewage Treatment Plants exceed the 25 ppm.

Because of the potential emissions of PCBs to the atmosphere, steps have been taken to conduct a stack test on one of these sludge incinerators. The performance of the New Bedford sludge incinerator will be tested during the fall of 1976.

B. Results of Field Investigation and Sampling Efforts

After completing the capacitor and manufacturing plant surveys, a limited field investigation and sampling program was undertaken to determine: 1. the potential for PCB migration from land disposal; 2. the potential for PCB air emissions from municipal incinerators; and 3. the feasibility of evacuating reject capacitors. The following are the results of our investigation.

1. PCB Land Disposal Sampling Program

Large quantities of PCB wastes are known to exist in land disposal sites in New England. As with other materials, the potential exists for movement of PCBs in leachate* from the land disposal sites causing contamination of surface and subsurface water. Because of this potential contamination, an investigation was undertaken of three categories of land disposal sites:

a) The first category consists of those disposal sites identified as having received substantial quantities of PCB liquid and/or solid wastes from the capacitor and transformer manufacturing plants in New England. Monitoring was conducted at three of the six sites

*Leachate is defined as liquid which has percolated through solid waste and has extracted dissolved and suspended materials from it.

(see Table 3) identified as having received wastes from the major PCB users. Two of those sites were selected because of the known existence of surface leachate and/or groundwater monitoring wells (Bennington, Vermont and Cranston, Rhode Island.)

The New Bedford municipal disposal site on Shawmut Avenue was selected as the third site because of the large quantities of PCB wastes in the site and its proximity to the Dartmouth, Massachusetts drinking water supply. Region I EPA funds were appropriated to hire a consultant geologist and to install monitoring wells at this site. The report of the geologist is attached (see Appendix B). Figure 2 shows the well drilling and relative proximity of the wells to the edge of the landfill.

b) The second category consists of sites receiving substantial volumes of industrial wastes but not specifically PCB wastes from capacitor and transformer manufacturing plants. Included in this category are Peabody, Massachusetts; Bristol and New Britain, Connecticut.

FIGURE 2. INSTALLATION OF MONITORING WELLS AT THE NEW BEDFORD, MASSACHUSETTS MUNICIPAL LANDFILL. (NOTE PROXIMITY OF WELLS TO EDGE OF LANDFILL).

c) The third category consists of disposal sites receiving primarily residential and commercial wastes. Included in this category are Danvers, Massachusetts; Bangor and Waterville, Maine; Windham and Beacon Falls, Connecticut.

The purpose of investigating these land disposal sites was to attempt to determine whether or not there was migration of PCBs out of these disposal sites. No attempt was made to determine the extent of any movement or to reach any conclusions concerning the significance of land disposal sites as a source of PCBs.

The five Category 3 sites were specifically chosen for the purpose of developing baseline or background levels of PCBs that might be released from post consumer wastes contained in municipal disposal sites.

Four different types of samples were collected. Samples were taken of surface leachate (containing solids and liquid) which is surface drainage that appears at the toe of a landfill. Samples were collected of groundwater where monitoring wells either existed or were installed. Soil samples were taken from split spoon cores acquired during the installation of monitoring wells. Finally, samples were taken from an industrial lagoon in Bennington, Vermont containing liquids and sludges. Figure 3 shows the industrial lagoon at Bennington, Vermont.

FIGURE 3. INDUSTRIAL WASTE LAGOON, BENNINGTON, VERMONT.

The results of the sampling effort are summarized in Table 5. In terms of detection, the greatest occurrence of detectable levels of PCB (lppb detection limit) took place at the sites known to have received PCB wastes from the major PCB users. At these sites, 9 out of 10 surface sampling points and 2 of 10 groundwater sampling points showed positive results for PCB.

The samples collected at refuse disposal sites receiving significant industrial contributions showed 0 of 3 surface sampling points and 1 of 1 ground water sampling points as containing greater than lppb of PCB. None of the 4 surface samples collected at the domestic waste landfills was above the detectable limit. (Groundwater samples were not collected at these sites).

EPA's Office of Solid Waste Management Programs has conducted a PCB sampling program at 11 landfills.[4] The sites were selected on the basis that they did not accept industrial PCB wastes. The range of valves found in the study were:

> leachate from municipal landfills -- less than 1 to 640 ppt.*
>
> groundwater in the vicinity -- less than 1 to 10 ppt.
>
> surface water in the vicinity -- less than 1 to 16 ppt.

*parts per trillion

TABLE 5

PCB LAND DISPOSAL SITE MONITORING RESULTS

Site Location Sampled	Type of Sample Collected	Sampling Method	Date Sample Taken	Analytical Results 1016	1254	1260
Category I (Sites receiving PCB Waste from major PCB users)						
A. New Bedford, Massachusetts Sanitary Landfill	1. Groundwater-GW-1	pump wells	3/26/76	N.D.[1,2,3]	N.D.	N.D.
	2. Groundwater-GW-2	"	"	1ppb	N.D.	N.D.
	3. Groundwater-GW-3	"	"	N.D.	N.D.	N.D.
	4. Groundwater-GW-4	"	"	N.D.	N.D.	N.D.
	5. Split Sample Leachate Seep	grab sample (near GW-3)	"	10ppb	N.D.	N.D.
		"	"	73ppb of Aroclor 1232[4]		
	6. Soil Sample-S-1 (0-7.5 ft.)	split spoons (from well GW-3	"	5800ppb	1700ppb	N.D.
	7. Soil Sample-S-2 (10-12 ft.	"	"	N.D.	N.D.	N.D.
	8. Soil Sample-S-3	"	"	N.D.	N.D	N.D.

Site Location Sampled	Type of Sample Collected	Sampling Method	Date Sample Taken	Analytical Results 1016	1254	1260
B. Sanitary Landfill Inc., Cranston, Rhode Island	1. Groundwater A	pump existing wells	4/8/76	N.D.	N.D.	N.D.
	2. Groundwater B	"	"	N.D.	2ppb	N.D.
C. Bennington, Vermont Municipal Landfill	1. Groundwater (L-1)	pump existing wells	1/20/76	N.D.	N.D.	N.D.
	2. Groundwater (D-2)	" " "	1/20/76	N.D.	N.D.	N.D.
	3. Groundwater (D-3)	" " "		N.D.	N.D.	N.D.
	4. Leachate Seep-A	grab sample	"	N.D.	N.D.	N.D.
	"	"	3/31/76	1300ppb	N.D.	N.D.
	5. Leachate Seep-B	"	5/4/76	liquid[5] 1ppb	N.D.	N.D.
				sediment 72ppb	52ppb	N.D.
	6. Leachate seep-C	"	5/4/76	liquid 5ppb	5ppb	N.D.
				sediment 110ppb	88ppb	N.D.
	7. Leachate seep-D	"	5/4/76	liquid 85ppb	N.D.	N.D.
				sediment 3900ppb	N.D.	N.D.
	8. Leachate seep-E operating lift	"	5/4/76	sediment 760ppb	N.D.	N.D.
	9. Leachate seep-F	"	5/4/76	liquid N.D.	N.D.	N.D.

Site Location Sampled	Type of Sample Collected	Sampling Method	Date Sample Taken	Analytical Results 1016	1254	1260
	10. Private Well	pump existing well	5/4/76	N.D.	N.D.	N.D.
	11. Industrial Lagoon	"	3/18/76	liquid 210000ppb	N.D.	N.D.
				sediment $4.0x10^7$	N.D.	N.D.
	12. Industrial lagoon	"	3/31/76	liquid 60,000ppb	N.D.	N.D.
Category II (Sites with large industrial contribution)						
A. Bristol, Connecticut Municipal landfill	Leachate (composite-2 leachate seeps)	grab sample	4/6/76	N.D.	N.D.	N.D.
B. New Britain Municipal Landfill Berlin, Connecticut	Groundwater	pump existing wells	"	24ppb	22ppb	N.D.
C. Peabody, Massachusetts Municipal Disposal Site	Surface Leachate	"	2/25/76	N.D.	N.D.	N.D.
Category III (Sites receiving primarily Residential Wastes)						
A. Bangor, Maine Municipal Disposal Site	Surface Leachate	grab sample	3/15/76	N.D.	N.D.	N.D.

Site Location Sampled	Type of Sample Collected	Sampling Method	Date Sample Taken	Analytical Results 1016	1254	1260
B. Beacon Falls, Connecticut Private Landfill	Surface Leachate	Grab Sample	4/6/76	N.D.	N.D.	N.D.
C. Danvers, Massachusetts Municipal Disposal Site	" "	" "	2/25/76	N.D.	N.D.	N.D.
D. Waterville, Maine Municipal Disposal Site	" "	" "	3/15/76	N.D.	N.D.	N.D.
E. Windham, Connecticut Municipal landfill	Leachate pond	" "	4/6/76	N.D.	N.D.	N.D.

Footnotes

1. Not detected. This indicates that the PCB level was below the detection limit. The detection limit when extracting 1,000 ml of water is 0.001 ug/ml (1 ppb). However, the detection limits of some of the Aroclors in these samples are higher because large amounts of one of the other Aroclors in a sample required that dilutions of that sample extract be used for quantification.

2. Unless otherwise indicated, PCB analysis performed by EPA National Enforcement Investigation Center, Denver, Colorado.

3. The gas chromatographic pattern of Aroclor 1016 greatly resembles that of Aroclor 1242 and it is not always possible to distinguish one from the other, especially in the presence of other Aroclors.

4. Analysis performed on split sample by Westinghouse Ocean Research Laboratory, Annapolis, Md. under contract with EPA - Suspect Sample Contaminated.

5. Samples with high solids content were centrifuged with the resultant liquid and solid fractions parately analyzed for PCBs.

The results of examining five soil samples taken at the surface sampling points in Bennington, Vermont and three split spoon samples collected at New Bedford, Massachusetts indicate that PCBs have a strong affinity for soil. The ability of soil to retain PCB in the long term, the rate of biological decay in the soil and the quantative removal capacity of various soils can not be determined from the limited data from this study.

The highest levels of PCBs found were in the liquid and sediment samples taken from the industrial lagoon in Bennington, Vermont. The concentrations of PCBs were considerably higher by a factor 1000 x in the solid phase as compared to the liquid phase, again demonstrating the high affinity of soil for PCBs.

In summary, the results of the landfill monitoring program indicate that PCBs are contained in the leachates leaving land disposal sites, however, no assessment of environmental impact can be made without better understanding of the long term movement of PCB in soil and groundwater.

2. PCB Emissions from Municipal Solid Waste Incineration

As previously noted, PCBs have had many historical uses which would cause them to appear in the conventional municipal solid waste stream. In New England there are still a considerable number of incinerators processing municipal solid wastes. Open hearth and other incinerators used for municipal refuse incineration are not normally suitable for destroying

Ta. 6

RESULTS OF AIR EMISSIONS TESTS

ON INCINERATION FACILITIES

Type of Facility	Waste Processed	Design Capacity	Emission Control Equipment	Sampling Point	Operating Temp During Test °F	Feed Rate of Waste During Test Tons/Hr.	Average Flow Rate of Stack Gas During Test (SCF Dry/Hr.)	Average Conc of PCB in Stack Gas Lbs/SCF Dry	Average Mass Emission Rate Lbs/Hr.
Stamford Conn. Municipal Incinerator	Mixed Municipal Solid Waste and dried Municipal Sludge	340 tpd refuse 20 tpd sludge @ 20% moisture	Electro-static Precipitators	Stack after Precipitator	1600°	17 tons refuse. 1 to 1.5 tons sludge (20% moisture)	6,595,018	4.2×10^{-9}	2.5×10^{-2}
Chicago[6] 211 Northwest Municipal Incinerator	Mixed Municipal Solid Waste	1600 tpd refuse	Electro-static Precipitator	Stack after Precipitator	1500° to 2000°	15 to 20	2,790,000	2×10^{-9}*	5.41×10^{-3}*
Palo Alto[7] California Municipal Multiple Hearth Sludge Incinerator	Municipal Sewage Sludge w/50ppm of PCB (dry solids basis)	1200 lbs./hr. of Sludge @ 15% solids	Scrubber	Stack after Scrubber	1100° to 1500°	0.60 to 0.80 dry solids	432,720	3.2×10^{-9} to 9.0×10^{-9}	1.46×10^{-3} to 4.13×10^{-3}
General[2] Electric Pittsfield Massachusetts liquid Injection Incinerator	Liquid Industrial Chlorinated oils containing PCB	Up to 4 gpm	Packed Bed Scrubber	Stack after Scrubber	1600° to 1800°	0.8 to 1.3 gpm	236,000	1.3×10^{-9}	3.2×10^{-4}

*Test data reported normally reflects combination of filter catch and impinger catch data. Chicago Northwest Incinerator testing, imping atch data is not included due to a .amination problem with the solvent.

PCBs. The relatively low operating temperature of such equipment would only volatilize the PCBs and pollute the atmosphere.

In order to assess the potential contribution of PCB to the atmosphere from the incineration of municipal solid waste, a stack test was conducted on the Stamford, Connecticut incinerator. This facility was chosen because it was of modern design, had a sampling point which complied with EPA's stack testing procedures, utilized acceptable emission control equipment, and processed municipal sludge as well as solid waste thereby providing a more comprehensive examination of the municipal wastestream.

The results of three sequential stack tests indicated that the stack gas contained an average concentration of 412×10^{-9} lbs. of PCB per standard cubic foot of gas emitted to the atmosphere. Based on the gas flows recorded during the test the mass emission rate for the Stamford incinerator was 2.5×10^{-2} lbs. of PCB per hr. Table 6 provides information on the operating conditions of the incinerator during the test.

Table 6 also reports available data on other PCB emission tests. This data has been presented in order to provide some insight into the relative significance of the Stamford test data. However, it should be noted that comparison of the Stamford data with the other reported test results is extremely difficult due to basic differences in sampling technique. Differences in the configuration of the sampling trains and variation in the solvents used in the impingers make detailed comparison impossible.

In general the available data indicates that of the sources tested, municipal refuse incinerators appear to have the highest PCB mass emission rate. The concentrations of PCB were the same order of magnitude for all the sources tested thus the higher mass emission rates from municipal solid waste incinerators are primarily a result of the larger volumes of waste processed and the higher gas flow rates.

In three of the four emission test reported in Table 6 the highest portion of the PCB was captured as a gas in the impingers. Only 5 to 6% of the total PCB catch was in the particulate category indicating that the majority of the PCBs are in fact volatilized in these processes.

Comparison of the concentrations observed in the stack gas from the processing facilities tested with the ambient air quality data in Table 7 indicates that the concentration of PCB in the stack gas is approximately 3 to 4 orders of magnitude greater than the reported background data. This comparison must also be viewed with caution due to the variation in ambient air sampling techniques utilized.

In summary PCBs have been isolated in the stack gas of several processing facilities, however the environmental significance of these results cannot be interpreted due to the lack of a standardized test procedure and the absence of health effects information for non occupational exposures.

3. Evacuation of off specification capacitors

As previously indicated in Table 2, Aerovox historically disposed of their solid PCB wastes in the New Bedford land disposal site. To date, further disposal of PCB wastes in this site has been prohibited by Massachusetts State officials. Subsequently Aerovox Industries,

TABLE 7

TEST RESULTS OF AMBIENT AIR SAMPLING

Location of Test	Date of Testing	Agency Sponsoring Tests	Concentrations	
			ng/m^3*	lbs/scf
Suburban Miami, Florida Jackson, Mississippi Fort Collins, Colorado Source: Reference 8	April - June 1976	Office of Pesticide Programs, EPA	100 (Ave. 3 locations)	6.0×10^{12}
Chicago, Illinois Source: Reference 6	October - November 1976	EPA, Region V, Chicago, Illinois	170 (Ave. Station 1) 140 (Ave. Station 2)	1.1×10^{-11} 9.0×10^{-12}
University of Rhode Island Kingston, Rhode Island Source: Reference 9	January - February 1973	University of Rhode Island	2.1 to 5.8	1.3 to 3.6×10^{-13}
Providence, Rhode Island Source: Reference 9	May 1973	University of Rhode Island	9.4	5.9×10^{-12}

*ng/m^3 = nanograms per cubic meter

Inc., initiated an experimental program to evacuate the liquid PCB from reject capacitors prior to disposal. The objective of this test program was to determine if the PCB in the reject capacitor could be reduced to a level sufficient to justify disposal in a municipal landfill.

The procedure utilized was based on one developed by Mallory Battery of Waynesboro, Tennessee. The procedure basically calls for puncturing the reject capacitors, placing them back in an impregnation chamber and subjecting the capacitors to heat (280° to 400° F) and vacuum for 24 to 48 hours.

PCB analysis was performed by the EPA and also by a private laboratory on the internal parts removed from several evacuated capacitors. While the results (see Table 8) from the two laboratories varied significantly, residual PCBs were still found in the evacuated reject capacitors.

Table 8

PCB Analysis of Evacuated Reject Capacitors

EPA Lab. Analysis	Private Lab. Analysis
grams of PCB/capacitor	grams PCB/capacitor
1. single capacitor - 3.0	1. composite sample (of 2 capacitors) .045
2. composite sample 2.2 (of 5 capacitors)	2. composite sample .06 (of 2 capacitors)

CHAPTER VI

REGULATIONS

The regulation and control of hazardous wastes (including PCBs) disposal on land has historically been a state responsibility. On October 22, 1976, this changed when new Federal Solid Waste legislation was signed into law. This new legislation authorizes EPA to develop through the states a uniform comprehensive hazardous waste regulatory program.

Following is a summary of the hazardous waste provisions of the new Federal solid waste legislation along with summaries of other Federal and state regulations and guidelines which impact on the management of PCBs in the environment.

1. Under Subtitle C of the Resource Conservation and Recovery Act of 1976, Section 3001 gives EPA 18 months after enactment to promulgate criteria for identifying hazardous wastes and list those wastes which shall be regulated. Also within 18 months after enactment, EPA must promulgate standards governing generators (3002) and transporters (3003) of hazardous wastes, as prescribed in the law, and performance standards for owners/operators of treatment, storage and disposal facilities (3004).

Section 3005 gives EPA 18 months to promulgate regulations requiring treatment, storage or disposal facilities to hold a permit issued by EPA or an authorized state program. Guidelines to assist development of state programs must be promulgated within 18 months after enactment under Section 3006.

Section 3007 authorizes Federal and state inspection of facilities and records and makes certain information publicly available. Section 3008 provides for Federal enforcement through compliance orders or civil action, after 30-day notices of violation are issued. EPA must give states with authorized programs 30 days to correct violations occurring there before taking action. Civil penalties may include fines up to $25,000 per day of violation; criminal penalties could reach $50,000 per day and two years imprisonment.

Section 3009 provides that no state or local government may impose less stringent hazardous waste management regulations. Section 3010 requires existing generators, transporters and facility operators to inform EPA or authorized states of their operations within 90 days after promulgation of Section 3001 regulations; all regulations would take effect six months after promulgation. Section 3011 authorizes $25-million in each of fiscal years 1978 and 1979 for grants to help states develop and implement hazardous waste programs, awarded according to need.

2. Under Section 204 of the Solid Waste Disposal Act as amended, EPA has developed "Recommended Disposal Procedures for PCB Wastes". The recommended procedures are addressed primarily to industrial users. Published in the April 1, 1976 Federal Register, Vol. 41, No. 64, the Recommended options for the disposal of PCB-containing wastes (in priority order) are:

Incineration

Controlled Land Disposal

Incineration should have a two-second dwell time at 1100°C and 3% excess oxygen in the stack, or a 1.5-second dwell time at 1500°C and 2% excess oxygen in the stack gas. Open hearth and other incinerators used for municipal refuse are not normally suitable, since the relatively low operating temperature would only volatilize the PCBs and pollute the atmosphere. Incineration of solid PCB-bearing wastes has not been demonstrated but appears to be feasible in suitably equipped furnaces.

The ubiquity and persistence of PCBs indicate that their disposal should be carefully controlled until additional data are developed. While these data are being gathered, PCBs (when disposed to the land) should be placed in a secure chemical waste landfill. In general terms, a chemical waste landfill provides complete longterm protection for the quality of surface and subsurface waters from hazardous waste deposited therein and against hazards to public health and the environment.

3. Under the New Toxic Substances Control Act of 1976 EPA will prohibit the manufacture, sale or distribution of polychlorinated biphenyls (PCBs) not in "enclosed systems," beginning one year after enactment, unless the EPA finds that continued use of PCBs in some other manner would not threaten health or the environment. Manufacture of all PCBs would be prohibited two years after enactment, and processing or distribution two and one half years after enactment, unless the agency makes exceptions. EPA must also issue labeling and disposal regulations by July 1977.

4. Under the Federal Water Pollution Act of 1972, EPA has proposed regulations (July 23, 1976 Federal Register) to limit the discharge of PCB. The regulations, which will take effect within 18 months, would prohibit any discharge of PCBs by industries manufacturing the chemicals. The prohibition also would apply, with some exceptions, to process wastes from industries using PCBs in the production of electrical transformers and capacitors, which is now the primary use of the chemical. Other types of discharges also would be controlled.

In addition to the specific discharge prohibitions, EPA's regulations would require manufacturers of electrical equipment containing the chemical to control PCB levels in non-process discharges. These include, for example, the runoff of storm water and cleaning water contaminated by the manufacturing process.

EPA's proposals would affect about 10 plants which use the chemical in the production of transformers and capacitors, and one plant which manufactures PCBs.

5. The Food and Drug Administration has set tolerances for PCB contamination of animal feeds, foods, and food packaging in its final rulemaking document published on July 6, 1973 (Federal Register, Vol. 38, No. 129). These tolerances, expressed as parts per million are as follows:

(1) Milk (fat basis)	2.5
(2) Dairy products (fat basis)	2.5

(3) Poultry (fat basis)	5.0
(4) Eggs	0.5
(5) Complete and finished animal feeds for food producing animals	0.2
(6) Animal feed components	2.0
(7) Fish and shellfish (Edible portion)	5.0
(8) Infant and Junior food	0.2
(9) Paper food - packaging material	10.0

On February 26, 1976, FDA announced that it is actively considering a lower temporary tolerance for fish in light of recent toxicological data concerning PCBs. FDA has also banned PCBs for use in food and feed processing.

6. On October 29, 1970, under the authority of (FIFRA) the Pesticides Regulation Division, administered then by the Department of Agriculture, issued a notice (PR Notice 70-25) to all pesticide manufacturers and distributors to eliminate the use of polychlorinated biphenyls and polychlorinated terphenyls from their formulation and products. Presently, there should be no pesticides on the market or in use containing PCBs.

7. Chemical hazards in the workplace are regulated under the Occupational Safety and Health Act (OSHA). The Secretary of Labor, in cooperation with the Secretary of Health, Education and Welfare, is authorized to set and enforce occupational safety and health standards applicable to businesses affecting interstate commerce.

In Title 29, Section 1910.93, the limits set for chlorodiphenyl compounds as an air contaminant are 1 mg per cubic meter for Aroclor 1242 and 0.5 mg per cubic meter for Aroclor 1254, based on 8 hours average exposure. The Department of Labor could enforce these limits on PCBs.

8. The State of Massachusetts has developed "Hazardous Waste Regulations" under Sections 27, 52, 57 and 58 of Chapter 21 of the General Laws. These regulations require the issuance of a permit by the Division of Water Pollution Control to handle, transport, process and dispose of hazardous wastes. Polychlorinated byphenols are included in the regulations under the category of "Solvents and Chlorinated Oils".

9. The Connecticut Department of Environmental Protection has developed administrative regulations requiring department approval for the processing and disposal of toxic or hazardous industrial wastes. Public Act No. 6-389 of the Connecticut General Laws specifically requires Department of Environmental Protection approval on all PCB disposal practices.

10. The Rhode Island Health Department has developed "Rules and Regulations for Solid Waste Management Facilities" which allow only those landfills having prior approval and utilizing specialized handling procedures to accept hazardous wastes.

11. In general all of the New England states have the authority to control PCB disposal practices through their general environmental and health laws and regulations.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. As a result of past PCB waste management practices utilized in New England, PCBs have been and continue to be emitted to the environment. This limited study identified concentrations of PCBs entering the environment in:
   A. surface and subsurface water samples from land disposal sites
   B. sludges from municipal wastewater treatment plants
   C. air emissions from a municipal solid waste incinerator

2. The several land disposal sites known to contain large quantities of industrial PCB waste present a strong threat for environmental contamination in the future.

3. While this study did not detect PCBs in the leachate from disposal sites which received only residential and commercial wastes, PCBs may be present at very low concentrations.

4. Due to the limited number of air, water, and sludge samples collected during the study and the lack of detailed information on the mobility and persistence of PCBs in the environment it is impossible to draw any conclusions concerning the environmental significance of the results. In general PCBs were detected at levels which exceeded two of the proposed Federal guidelines: PCB concentrations in municipal sludge exceeded the 25mg/kg monitoring threshold proposed in EPA's technical Bulletin[3] on sludge, and PCB concentrations in liquid discharges from land

disposal sites exceeded the proposed wastewater effluent discharge limit of 1 PPB[10].

5. The five capacitor and one transformer manufacturing plants surveyed in New England are aware of the potential problems associated with PCBs and are attempting to both minimize the amounts of waste generated and to improve PCB waste disposal methods. Aerovox Industries, Inc., of New Bedford, Massachusetts is investigating a technique for evacuation of waste capacitors and subsequent reuse of the PCBs. General Electric of Pittsfield, Massachusetts has constructed a liquid waste incinerator that in addition to destroying internally generated PCB wastes, accepts PCB liquid wastes generated by other firms.

6. Incinerator facilities (See Appendix A) are available and are currently being utilized to adequately dispose of the liquid PCB wastes being generated in New England.

7. Regardless of industry efforts to improve in plant operating practices, there remains a need to dispose of unrecoverable wastes - particularly PCB contaminated solid waste. There are no State approved "Chemical Waste landfills" or hazardous waste management processing facilities planned or operating in New England that could process and dispose of solid PCB wastes in an environmentally acceptable manner.

8. At present, PCB waste management practices as well as other hazardous waste management practices are in general unregulated at the Federal, state and local level. With the enactment of the Resource Conservation and Recovery Act of 1976, either state or Federal programs will be developed by October 1978, to adequately manage hazardous wastes.

Recommendations

As a result of these findings, the Region I Solid Waste Program of the U.S. Environmental Protection Agency recommends the following:

1. Ground water monitoring wells should be installed at sites known to have accepted large quantities of industrial PCB wastes. The wells should be sampled and analyzed for PCB on a continuous basis. If the monitoring results indicate potential problems, corrective action should be taken.

2. Processing and disposal of PCB wastes should be in conformance with the U.S. Environmental Protection Agency's recommended procedures for disposal of PCBs published in the Federal Register on April 1, 1976 (Vol. 41 No. 64, p. 14134) or state regulations whichever are more stringent.

3. Processing and disposal of municipal sewage treatment plant sludges should be in conformance with the U.S. Environmental Protection Agency's Municipal Sludge Management Technical Bulletin published in the Federal Register on June 3, 1976 (Vol. 41, No. 108, P. 22532).

4. Industry must further improve their ongoing efforts to reduce the utilization of PCB's as a raw material, increase recycling of waste inplant, decrease amount of solid waste generated and properly process and dispose of waste residuals. Costs for environmentally acceptable processing and disposal options should be internalized for all residual wastes. This cost accounting may result in justification for further inplant processing of wastes for recovery.

5. The New England states and industry should work together to resolve existing disposal problems. Industries in close proximity to one another may find it advantageous to reduce individual costs, to explore a regional solution themselves.

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APPENDIX A

PCB TREATMENT OR DISPOSAL FACILITIES

> The firms listed below (not all-inclusive) will accept PCBs for treatment or disposal, as noted. The Environmental Protection Agency does not endorse any of these firms and cannot vouch for the enviromental adequacy of their operations. Each of these firms has been contacted and reports having the required technical characteristics to adequately handle PCBs, in accordance with Recommended Procedures for the Disposal of PCB-Containing Waste (Industrial Facilities) as published by EPA in the *Federal Register*. The appropriate State or EPA Regional Office should be consulted for environmental suitability of the firm/site.

1. California Class I Landfills

(a) Casmalia Disposal Site
Santa Barbara, California (805-969-4703)
Bulk liquids and drummed materials.

(b) BKK Corporation
Wilmington, California (213-775-3607)
All forms.

(c) Environmental Protection Corporation
Bakersfield, California
All forms.

(d) County of Los Angeles
Whittier, California (213-699-7411)
Facilities: Palos Verdes
Calabasas
All forms.

(e) Richmond Sanitary Service
Richmond, California (415-234-3304)
All forms.

(f) San Diego County
San Diego, California (714-565-5703)
All forms.

(g) Ventura County Dept. of Public Works
Ventura, California (805-648-2717)
All forms.

2. Chemical Waste Disposal Co.
   Elizabeth, N.J. (201-351-5460)
   Disposal by incineration

3. Chem-Trol Pollution Services, Inc.
   Model City, N.Y. (716-754-8231)
   Can handle solids and liquids by incineration or land disposal.

4. General Electric Corp.
   Pittsfield, Mass. (413-494-3729)
   Can handle only liquids and complete transformers. Liquids are incinerated.

5. Hyon Waste Management Services, Inc.
   Chicago, Ill. (312-646-0016)
   Can handle solids and liquids by incineration

6. Monsanto Company.
   St. Louis, Mo. (800-325-3850)
   Handles only liquid askarels manufactured by Monsanto
   Disposal is by incineration.

7. Nuclear Engineering Co., Inc.
   Louisville, Ky. (502-426-7160)
   Facilities: Sheffield, Ill.
   Beatty, Nev.
   Disposal by landfill. Can handle drummed liquids and solids.

8. Rollins Environmental Services
   Main Office: Wilmington, Delaware (302-658-8541)
   Facilities: Bridgeport, N.J.
   Baton Rouge, La.
   Houston, Texas
   Can handle solids and liquids by incineration.

9. Texas Ecologists, Inc.
   Robstown, Texas (512-387-3518)
   Disposal by landfill.

10. Wes Con, Inc.
    Twin Falls, Idaho (208-733-0897)
    Receive packaged materials for disposal in missile silos.

DONALD E. REED CONSULTING GEOLOG

1093 MAIN STREET . NORWELL, MASS 02601 . . . 617-659-7833 . . .

8 April 1976

U. S. Environmental Protection Agency
J. F. K. Federal Building, Room 2113
Boston, Massachusetts 02203

Attention: Mr. Ira Leighton

Subject: Ground Water Monitoring Wells
New Bedford Municipal Landfill
New Bedford, Massachusetts

Gentlemen:

This letter reports on the installation of four ground water monitoring wells at the New Bedford Municipal Sanitary Landfill during the period 24 through 26 March 1976. The purpose of the wells is to provide a means of sampling ground water adjacent to the site so that tests could be performed for the presence of polychlorinated biphenyls in the ground water. The work was undertaken at the request of Mr. Ira Leighton and was performed in accordance with your Order No. WB6990536A, dated 3 March 1976.

Ground Water Monitoring Wells

The monitoring wells were installed by the Test Boring Division of Clarence Welti Associates under a separate contract with the Environmental Protection Agency. The installations were under the direct supervision of the writer. The contractor's boring logs are enclosed with this report.

The wells were installed in the swamp, adjacent to the toe of the slope of the eastern edge of the landfill. The approximate locations are shown in red on the enclosed 500 scale Algonquin Gas Transmission Co. aerial photograph, their drawing No. L-5838A, Sheet 2 of 2.

Wells were installed in drive sample borings using BX (2 3/8-inch I.D.) flush joint casing. The casing was driven and washed out with fresh water prior to obtaining each sample. Samples were taken using a standard 2-inch O.D. split spoon sampler and were transferred to specially treated sample jars immediately after removal from the bore hole. These jars were provided by the Surveillance and Analysis Section of the EPA.

The wells consisted of 3 to 3.5 foot long sections of 1 1/4-inch I.D. No. 10 PVC well screen (slot width .01 inch) attached to a 1 1/4-inch I.D. PVC riser pipe extending from 1 1/2 to 2 feet above ground surface. Each well screen was encased in a fine nylon stocking to inhibit silting and ensure satisfactory operation of the well in the fine grained soils encountered.

After installation of the well screen and riser, all of the BX casing was withdrawn with the exception of the lower 5 foot section. This was left in the bore hole with the top of the casing approximately 6 to 8 inches above ground surface. Approximately 5 pounds of bentonite pellets were then rodded down the outside of the casing to provide a water tight seal between soil and casing and prevent surface water from seeping down the side of the casing into the well.

Site Geology

The landfill site is located toward the southern end of a large glacial lake deposit that extends from Apponagansett Swamp to the northern limit of Acushnet Cedar Swamp. The inorganic soils underlying the site, as revealed by the four borings made for the well installations are typical glacial lake deposits and consist of a thin layer of silty fine sand at the top underlain by stratified silts and clayey silts with thin layers of silty clay. The inorganic soils are capped with a layer of fresh water peat varying from 7 to 10 feet thick at the location of the borings.

The total thickness of the deposits, inorganic and organic, at the location of monitoring well OW1 is 42 feet. Since the glacial lake at the site, formed in a shallow glacial till basin, it is probable that the maximum thickness anywhere within the lake deposit is not much greater than this.

Ground Water Flow

All of the virgin soils underlying the landfill have relatively low permeabilities. It is estimated from past experience that the silts and peat at the site have permeabilities in the order of 1×10^{-6} ft./min. or less. The only soil that is moderately permeable is the thin stratum of interbedded silty fine sand and sandy silt at the top of the lake deposits, just beneath the peat. This stratum is approximately 4 to 6 feet thick.

A number of field permeability tests were performed in this layer during installation of the wells. From these tests and from data on grain size and relative density (determined from estimated grain size and blow counts from the standard penetration test) the permeability of the stratified silty fine sand and sandy silt layer has been estimated to be about 1×10^{-4} ft./min.

The ground water gradient in the area is extremely flat and no measurements of the gradient were made during this study. An estimate may be made, however, by calculating the gradient of a surface flow path in the swamp from the U.S.G.S. topographic quadrangle map of the area (New Bedford North). The gradient determined by this method is approximately 0.001.

Utilizing this gradient, a permeability of 10^{-4} ft./min. and an estimated porosity of 40 percent, we can calculate the velocity of flow of ground water away from the landfill. This calculation yields a flow velocity of about 0.1 ft./year. It must be stressed that all of the quantities that have entered into this calculation have been estimated. A change in the permeability and the gradient of one order of magnitude each could change this velocity value by a factor of 100, increasing it to 10 ft./year. This is still a very low rate of flow, however, and it indicates that ground water flow and, therefore, potential leachate flow (in the ground water) is extremely slow.

<u>Probable Leachate Flow</u>

The seepage of leachate into the underlying ground water at this site is believed to be significantly reduced by the occurrence of the relatively impervious peat layer under the landfill. Peat is relatively impervious in its natural state, but when compacted it becomes even more impermeable.

Significant leachate could percolate thru the fill if there were breaks and gaps in the peat membrane, but the history of filling at this site lessens this possibility.

The site began as an open dump in 1926 and continued as such into the summer of 1971. At this time the dump was converted into a sanitary landfill. Often the filling of shallow peat deposits with dense granular materials, e.g., filling for roadway or railroad embankments causes a total displacement of the peat and the development of a so called "mud wave" in the peat out in front of the fill. Filling with rubbish and other comparatively light weight, solid wastes does not cause displacement and thus the peat membrane remains intact. As the fill height is increased, the peat continues to consolidate and as it does it becomes increasingly more impervious.

From the foregoing, there is a strong possibility of the existence of a more or less continuous, relatively impervious peat membrane underlying the landfill at the New Bedford site. This peat membrane would restrict the flow of leachate to the surface of the peat with only minor flow into the underlying ground water. This is only an hypothesis at this stage, however, and considerably more detailed soils and hydrogeological investigations would be required to verify this as well as more accurately define the velocity and direction of ground water flow.

Thank you for inviting me to work with you on this project. If you have questions or need additional information, please do not hesitate to contact me.

Sincerely yours,

Donald E. Reed

DER:o
Enclosures

NEW BEDFORD MUNICIPAL LANDFILL
WATER QUALITY DATA FROM
GROUNDWATER MONITORING WELLS OW1-OW4

Location	Time	Temp. °C	Conductivity (micromhos)
OW1	11:10 a.m.	18.5	340
Surface Leachate Vicinity OW1	11:15	22.0	2020
OW2	1:10 p.m.	14.0	150
OW3	1:30	13.8	160
Surface Leachate Vicinity OW3	1:35	-	2700
Leachate Seep, Toe of Slope at OW3	1:45	14.8	2500
OW4	2:05	11.5	150

Note: Measurements made on 26 March 1976 using a Yellow Springs Instrument Co. VSI Model 33 S-C-T Meter.

CLARENCE WELTI ASSOC., INC
100 SYCAMORE STREET
GLASTONBURY, CONN 06033

"BORING LOG"

NEW BEDFORD LANDFILL
PROJ. NEW BEDFORD, MASS.
CLIENT EPA

BORING NO. OW-1
LINE & STA.
OFFSET
GR. ELEV.

BORING NO.
LINE & STA.
OFFSET
GR. ELEV.

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
	BLK. ORGANIC PEAT	PUSH	
8.0	GR. SILT & FINE SAND	4-7-9	
13.5	GR. SILT	5-10 11-12	
18.0			
19.0	GR. SILT & CLAY	NO BLOWS	
	GR. SILT	5-9 11-12	
23.0	GR. CLAY & SILT	5-7 9-8	
35.0	GR. CLAY & SILT, TR. BR. SILT IN LAYERS	9-11 11-13	
42.0			
44.0	POSSIBLE TILL		
45.0	**		

A	STRATUM DESCRIPTION	BLOWS PER ___	B
	1 WELL POINT 14' DEEP 3'6" WELL SCREEN		
	** SOFT BEDROCK OR BOULDER		
	REFUSAL ON ROLLER BIT 45. WATER AT 2.0 @ 0 HRS.		

DATE: 3/23/76
DRILLER: MOODIE

1. COL. A STRATA DEPTH
2. COL. B
3. HAMMER = 140#; FALL 30"
4. SAMPLER = ______ O.D. SPLIT SPOON
5. GWT = GROUND WATER

AND - 40 to 50%
SOME - 10 to 40%
TRACE - 0 to 10%

CLARENCE WELTI ASSOC. INC
100 SYCAMORE STREET
GLASTONBURY, CONN 06033

"BORING LOG"

PROJ. NEW BEDFORD LANDFILL NEWBEDFORD, MASS.

CLIENT EPA

BORING NO. OW-2

LINE & STA.
OFFSET
GR. ELEV.

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
	ORGANIC PEAT		
9.7		PUSH	
	GR. FINE SAND, SOME SILT	6-6	
		7-7	
13.5			
	GR. SILT, TR. CLAY	8-12	
17.0		15-19	
	BOTTOM OF BORING 17.0		
	WATER AT 0.2 @ 0 HRS.		
	DATE: 3/25/76		
	DRILLER: MOODIE		
	1 WELL POINT 13' DEEP		
	3'6" WELL SCREEN		

BORING NO. OW-3

LINE & STA.
OFFSET
GR. ELEV.

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
	ORGANIC PEAT		
7.5		PUSH	
	GR. FINE SAND, SOME SILT	6-9	
		12-12	
13.0			
	GR. SILT, TR. CLAY	9-14	
17.0		15-29	
	BOTTOM OF BORING 17.0		
	WATER AT 1.2 @ 0 HRS.		
	DATE: 3/25/76		
	DRILLER: MOODIE		
	1 WELL POINT 11.2 DEEP		
	3' WELL SCREEN		

1. COL. A STRATA DEPTH
2. COL. B
3. HAMMER = 140#; FALL 30"
4. SAMPLER = O.D. SPLIT SPOON

AND - 40 to 50%
SOME 10 to 40%
TRACE - 0 to 10%

CLARENCE WELTI ASSOC. INC
100 SYCAMORE STREET
GLASTONBURY, CONN 06033

"BORING LOG"

PROJ. NEW BEDFORD LANDFILL
NEW BEDFORD, MASS.
CLIENT EPA

BORING NO. OW-4
LINE & STA.
OFFSET
GR. ELEV.

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
	ORGANIC PEAT, TR. WOOD		
9.0		PUSH	
	GR. FINE SAND & SILT, TR. CRS. SAND	7-10	
		9-10	
		12-16	
		12-12	
15.0		10-14	
16.0	GR. SILT	17-12	

BOTTOM OF BORING 16.0
WATER AT SURFACE @0 HRS.

DATE: 3/26/76
DRILLER: MOODIE

1 WELL POINT 14.7' DEEP
3'6" WELL SCREEN

BORING NO.
LINE & STA.
OFFSET
GR. ELEV.

A	STRATUM DESCRIPTION	BLOWS PER	B

1. COL. A STRATA DEPTH
2. COL. B
3. HAMMER = 140#; FALL 30"
4. SAMPLER = O.D. SPLIT SPOON
5. GWT = GROUND WATER

AND - 40 to 50%
SOME - 10 to 40%
TRACE 0 to 10%